The American Biology Teacher

Vol. 7 FEBRUARY, 1945 No. 5

PUBLISHED BY
The National Association of Biology Teachers

Entered as second class matter October 26, 1939, at the post office at Lancaster, Pa., under the Act of March 3, 1879.

To All Readers:

Make yourself a committee of one to assist the membership committee in increasing our membership to 3000 this year. Have some friend send in this application today.

THE NATIONAL ASSOCIATION OF BIOLOGY TEACHERS ☐ NEW

M. A. RUSSELL, Secretary-Treasurer,
403 California Ave., Royal Oak, Mich. ☐ RENEWAL

I hereby apply for membership in The National Association of Biology Teachers and enclose $1.50 as my annual membership dues $1.20 of which is for a year's subscription to The American Biology Teacher. (Subscription may not be had separately)

M ______________________________

Please Print Name

____

Street and Number

____

City and State

SCHOOL .... POSITION ....

Local biology teachers association of which I am a member ....

THE AMERICAN BIOLOGY TEACHER

Publication of The National Association of Biology Teachers.
Issued monthly eight times during the school year from October to May.
Publication Office—N. Queen St. and McGovern Ave., Lancaster, Pennsylvania.

Correspondence concerning manuscripts may be addressed to any of the Associate Editors or directly to the Editor-in-Chief. Books and pamphlets for review should be sent to the Editor-in-Chief. Subscriptions, renewals, and notices of change of address should be sent to M. A. Russell, Secretary-Treasurer, 403 California Ave., Royal Oak, Mich. Annual membership, including subscription, $1.50.

The American Biology Teacher

Vol. 7 FEBRUARY, 1945 No. 5

Chemical Gardening in the High School Laboratory*

KARLEM RIESS
Tulane University, New Orleans, Louisiana

During the past five years much publicity has been given to methods of growing plants without soil. Whether the process be termed hydroponics, aquaculture, chemical gardening, chemiculture, psammoponics or soilless gardening, the basic principle is the same—the use of a nutrient solution to furnish the chemical elements necessary for plant growth. As a result of this publicity a group of high school biology students devised a very successful extra-curricular laboratory project to demonstrate the various types. This report is a summary of the methods used and results obtained during a two-year period.

Historical Background

Growing plants without soil is not a new, magic discovery. A seventeenth-century experimenter, Woodward, grew spearmint in water solutions. Before 1840 Jean Boussignault raised plants in soil substitutes, such as sand, powdered quartz and charcoal, feeding them with nutrient solutions. Direct water culture began about 1860 when Sachs and Knop used nutrient solutions without supporting media (2). Some of the general techniques of these investigators are accepted today. Prior to 1920 various nutrient mixtures were prepared by Tollens, Schimper, Pfeffer, Crone, Tottingham, Shive and Hoagland (2). In 1921 Pember and Adams, studying carnations at Rhode Island Experiment Station, found that they would grow in sand to which nutrients were added (6). Modern consideration of plant culture with nutrient solutions for commercial purposes was suggested by W. F. Gericke, formerly of the University of California Experiment Station, in 1929. Through his efforts much interest was aroused in the subject, and many greenhouse installations begun by nurserymen (12).

The Gericke method is true water culture, growing plants directly in a nutrient solution, or in trays suspended into nutrient solutions. The original method has been improved by many workers, notably D. R. Hoagland and D. I. Arnon of the University of California Experiment Station (2, 12).

This was followed by "slop culture." In this method the plants are grown in sand or sand mixtures in ordinary greenhouse benches. The benches were watered with a nutrient solution several times a week, alternating with watering with tap water (13).

Mid-western commercial growers have adopted gravel or sub-irrigation culture, developed by Robert Withrow and Joel Biebel of Purdue University in 1936 (4). The plants are grown in gravel or a similar mineral aggregate, in waterproof benches of

* The work outlined in this paper was carried on under the supervision of the author at Alcee Fortier High School, New Orleans, Louisiana.

wood or concrete, into which nutrient solution is pumped at regular intervals by means of a centrifugal pump with time clock attached.

Sand culture is the simplest method for laboratory work. Perfected by J. W. Shive of the New Jersey Agricultural Experiment Station, the plants are grown in cleaned sand, watered by overhead irrigation, by periodic flooding, or some modification (3).

A combination, the bench-bucket method, was devised by Wayne I. Turner. The nutrient solution is placed in a special bucket, raised to a convenient height above a wooden bench, so that the solution will flow into the bench by gravity. When the bucket is empty it is placed below the bench to catch the used solution (14).

Laboratory adaptations of these different methods were developed by the students themselves, following general directions in reference pamphlets and texts. A complete list is given in the bibliography.

Organization of Project

The students volunteering for the project were a group of boys, between thirteen and fifteen years of age, sophomores at the Alcee Fortier High School, New Orleans, Louisiana. Throughout the project some twenty boys participated. Previous scientific training was limited to a year course of general science. At the start all of the boys were taking elementary biology. Many of them continued the work while studying elementary chemistry the following year. On the average, at least one hour per day per student was spent on project work. This was in addition to the regular academic work. No extra credit was given for the work.

The students were allowed to arrange their own groups or partnerships for the project. A general lecture was given to all of the groups on the aim of the project and the historical developments outlined above. All available reference materials—texts, pamphlets, trade literature, etc.—were placed on a reserve shelf in the laboratory for frequent consultation. The groups decided to work on a competitive basis, each group selecting a different nutrient formula, and using it in a series of experiments based on the general methods for culture. Group results were compared at intervals, and the progress of the work noted in report form.

Seed Culture. Groups may start their seeds in several different ways. Perhaps the simplest is to germinate the seeds on moistened filter or blotting paper, keeping the paper moistened with the nutrient solution. A better method is to place the seeds on a piece of paraffined cheesecloth stretched over a pan of nutrient solution, with the level of the solution adjusted so that the seeds are always moist (1, 3). The seedlings may be readily removed from the paraffined cloth for planting. Some workers prefer to germinate seeds in trays of sand, watering frequently with nutrient solutions. All of these methods give satisfactory results. Each was tried by the students. Figure 1a.

Sand Culture. A quartz sand, of low alkali content, is desirable. The sand should be thoroughly washed and sterilized by heating. The seedlings (or larger plants if desired) are placed in washed, cleaned flower pots filled with the sand. The pots may be glazed or ordinary clay, minimum four to six inches in diameter. For this type of culture two laboratory procedures are possible.

One is the drip method using an inverted Mason jar as a reservoir for the nutrient solution, with a capillary outlet leading into the flower pot itself. As seen in Figure 2 the pot is raised on a small support to secure good drainage. The solution is collected in a dish or pan and may be used again. If capillary tubing is not available, ordinary glass tubing, a small piece of rubber tubing, a screw compressor clamp and a drawn glass tip may be used. For such a drip a flow of one to two quarts per plant per day is needed, changing the solutions

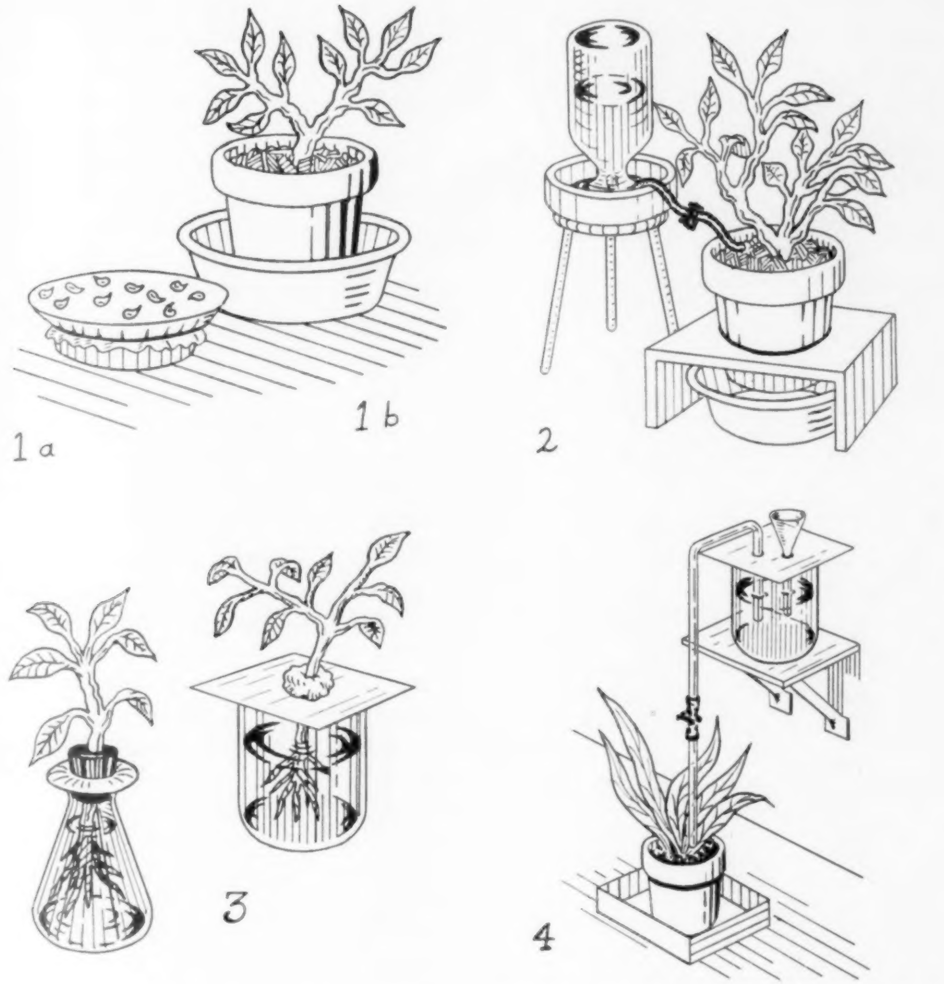
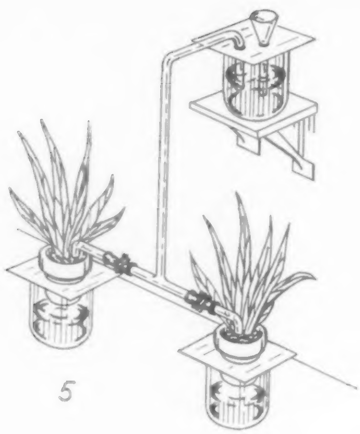


FIG. 1. (a) Seed culture; (b) sand culture. FIG. 2. Drip method for sand culture. FIG. 3. Water culture. FIG. 4. Modified drip method for aggregates or sand.

about once or twice a week. This will depend on the general condition of the plant. Glazed pots were found best for this method (**1**, **3**, **11**).

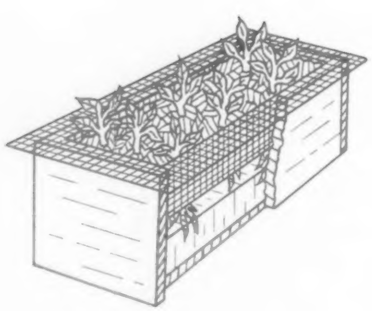
In the second procedure an ordinary clay flower pot is placed in a small enameled pan containing the nutrient solution. The sand is watered daily with a fine spray. A chemist's wash bottle was found convenient for this purpose. Capillary action keeps the roots moist between sprayings. This method does not always give satisfactory results because the aeration is poor. Figure 1b.

Water Culture. Direct water culture is readily set up in the laboratory. The simplest arrangement is to suspend a plant directly in the nutrient solution. The solution may be contained in a Mason jar, a goldfish bowl, battery jar, Erlenmeyer flask, or a glazed porcelain container. If the vessel has clear sides it will be advantageous to paint the sides so that the sun will not reach the rootlets. For this method the plants, if large enough, may be suspended through a wooden support, or through a large cork, and held in place by cotton or excelsior.



5

6



7

FIG. 5. Double drip culture. FIG. 6. Bucket-bench method. FIG. 7. Tray culture.

If the plant is small, it may be placed in a wire mesh basket, filled with glass wool, peat moss, straw or excelsior, and then the basket suspended into the solution. Aeration is important in this method. The plant or basket should be raised from the solution each day, care being taken not to allow the roots to dry while raised. This will give sufficient aeration. Figure 3.

A continuous flow system may be used. In this type the nutrient drips into the plant reservoir, and excess flows off into a separate receptacle. This method aids aeration by carrying dissolved air to the roots. There are a number of disadvantages in the practical operation of this method. Good results may not be obtained as readily as in the other type.

Mineral Aggregate Culture. For this type native gravels, glass wool, pumice, Haydite and cinders have been used advantageously. For laboratory specimens the aggregates are placed in flower pots or glass bowls. No basket or ring supports are necessary for plants placed in the aggregates. The nutrient solutions are either dripped on to the plant, or placed directly in the bowl. Figures 4, 5. (1, 3, 13.)

For the larger commercial installations, these mineral aggregates have been used in specially designed greenhouse benches. The benches may be flat or V-bottom, wooden or concrete, with some sort of mechanical pumping system for circulating the nutrient solution and draining it at regular intervals. The commercial Winandy bench is most desirable for proper drainage. Details for bench construction and use on a small scale may be obtained from reference texts (1, 3, 4, 5, 6, 11, 12, 13, 14). They are not given here because such installations are not feasible in the usual school laboratory or small greenhouse.

Laboratory-Size Benches. There are

two greenhouse methods which are adaptable to laboratory conditions. One is the so-called bench-bucket type, consisting of a waterproofed trough or bench, with the solution entering from a suspended enameled bucket through a flexible tube, so that when the solution has filled the trough, the bucket may be placed below the trough, and the solution drained back into the bucket. A small installation may be constructed for laboratory use. Gravel or other aggregates are used to support the plants. Figure 6. (13, 14.)

The Gericke tray culture may be designed on a small scale. A waterproofed wooden trough may be constructed with a suspended basket or tray. The plants are placed in the tray, in a medium of peat moss, excelsior or straw. The roots will go through the supporting medium into the solution in the tank itself. It is best to provide some sort of tap for withdrawal of the solution from the bottom of the tank. Aeration is usually necessary with this method. Small troughs, 8 × 8 × 24 inches, were constructed by the students. They were made of half-inch cypress, and waterproofed with Johns-Manville Chemstone Cement. A wire mesh basket filled with excelsior and peat moss was suspended into the trough. Figure 7. (1, 2, 6, 11, 12, 14.)

Nutrient Solutions

The students used five different nutrient formulae, as indicated in the tabulated results. These were the standard solutions cited in available texts as most successful for amateur work. The students first familiarized themselves with chemical symbols, atomic weights, molecular weights, and the meaning of molar quantities. In short, some elementary chemical calculations were made, and solutions of specified dilutions prepared under supervision. The students prepared all of the nutrient solutions themselves according to the prescribed formulae.

1. *The University of California Experiment Station Solution #1* — Hoagland and Arnon (2).

M KH_2PO_4—Primary potassium orthophosphate —1 cc./liter.
M KNO_3—Potassium nitrate—5 cc./liter.
M $Ca(NO_3)_2$—Calcium nitrate—5 cc./liter.
M $MgSO_4$—Magnesium sulfate—2 cc./liter.
(Quantities per liter of nutrient solution)

2. *The University of California Experiment Station Solution #2* — Hoagland and Arnon (2).

M $NH_4H_2PO_4$—Primary ammonium orthophosphate—1 cc./liter.
M KNO_3—Potassium nitrate—6 cc./liter.
M $Ca(NO_3)_2$—Calcium nitrate—4 cc./liter.
M $MgSO_4$—Magnesium sulfate—2 cc./liter.
(Quantities per liter of nutrient solution)

To both of these solutions two supplementary solutions must be added:

Trace Solution #1:

H_3BO_3—Boric acid—2.86 gm./liter.
$MnCl_2 \cdot 4H_2O$—Manganese chloride—1.81 gm./liter.
$ZnSO_4 \cdot 7H_2O$—Zinc sulfate—0.22 gm./liter.
$CuSO_4 \cdot 5H_2O$—Copper sulfate—0.08 gm./liter.
$H_2MoO_4 \cdot H_2O$—Molybdic acid (85% MoO_3)—0.02 gm./liter.
(Quantities per liter of water)

1 cc. of this solution is added to each liter of nutrient solution used, or more frequently if need arises.

Trace Solution #2:

0.5% iron tartrate solution, or other suitable iron salt, at rate of 1 cc. per liter of nutrient solution, once or twice a week. Ferric chloride, $FeCl_3$, was used in most of the student experiments.

3. *New Jersey Agricultural Experiment Station Formula #1*—Shive and Robbins (1, 3).

KH_2PO_4—Primary potassium orthophosphate—5.9 gm.
$Ca(NO_3)_2 \cdot 4H_2O$—Calcium nitrate—20.1 gm.
$MgSO_4 \cdot 7H_2O$—Magnesium sulfate—10.7 gm.
$(NH_4)_2SO_4$—Ammonium sulfate—1.8 gm.
(Quantities per 5 gallons of solution)

Two supplementary solutions are needed with this formula:

Stock Solution A:

H_3BO_3—Boric acid—0.8 gm./1 pint water.
$MnSO_4 \cdot 7H_2O$—Manganese sulfate—0.8 gm./1 pint water.
$ZnSO_4 \cdot 7H_2O$—Zinc sulfate—0.8 gm./1 pint water.

In addition to these, Ellis and Swaney (1) recommend addition of one-eighth teaspoonful of copper sulfate solution. 10 cc. of A

are used to each 5 gallons of culture solution.

Stock Solution B:

0.8 gram ferrous sulfate, $FeSO_4$, or ferric chloride, $FeCl_3$, dissolved in 1 pint of water. 20 cc. of B are added to each gallon of culture mixture.

4. *Purdue University 2D Solution*—Withrow and Biebel (4).

$MgSO_4 \cdot 7H_2O$—Magnesium sulfate—123 grams.
$Ca(H_2PO_4)_2 \cdot H_2O$—Monocalcium orthophosphate —126 grams.
KNO_3—Potassium nitrate—1010 grams.
$CaSO_4 \cdot 2H_2O$—Calcium sulfate—688 grams.
$(NH_4)_2SO_4$—Ammonium sulfate—132 grams.
(Quantities per 1000 liters of water)

Microelement supplement:

$FeSO_4 \cdot 7H_2O$—Ferrous sulfate (5 p.p.m. Fe)—25 grams.
$MnSO_4 \cdot 4H_2O$—Manganous sulfate (0.5 p.p.m. Mn)—2 grams.
$CuSO_4 \cdot 5H_2O$—Cupric sulfate (0.05 p.p.m. Cu) —0.2 gram.
$ZnSO_4 \cdot 7H_2O$—Zinc sulfate (0.05 p.p.m. Zn)—0.2 gram.
H_3BO_3—Boric acid (0.5 p.p.m. B)—3 grams.
(Quantities per 1000 liters of water)

5. *Ohio State University WP Formula*—Laurie (6).

KNO_3—Potassium nitrate—5 lb. 13 oz.
$(NH_4)_2SO_4$—Ammonium sulfate—15½ oz.
$Ca(H_2PO_4)_2 \cdot H_2O$—Monocalcium orthophosphate —2 lb. 6 oz.
$CaSO_4 \cdot 2H_2O$—Calcium sulfate—10 lb. 11 oz.
$MgSO_4 \cdot 7H_2O$—Magnesium sulfate—4 lb. 8 oz.
(Quantities per 1000 gallons of water)

Trace Solution #1:
1 oz. manganese sulfate in 1 gallon of water. Two quarts of this solution are added to each 1,000 gallons of complete solution.

Trace Solution #2:
4 oz. ferrous sulfate to each 1,000 gallons of complete solution.

In the preparation of the above solutions, the students made up 5 or 10 liters at one time, since facilities for handling larger amounts were not available. Distilled water and chemically pure (CP) chemicals were used in each case.

Solution Testing. An important factor in the use of any nutrient solution is its pH value. Tables of pH values desirable for most common plants are available. pH tests, either with commercial test papers or with indicators, should be made of the water of the community, and of the solutions after preparation. It may be necessary to bring the pH to its proper value by the addition of dilute sulfuric acid or dilute ammonium hydroxide. This alteration was necessary in New Orleans with city water pH varying between 9.0 and 10.0. Most of the nutrient solutions should be maintained at a pH between 5.0 and 6.5. Frequent tests on the solutions after days of use, or days of standing without use, should be made, particularly if any external chemical changes, such as precipitation, are visible. Students readily made the tests with the commercial papers, or with brom-thymol blue, a spot plate and color chart.

Some commercial growers test the solutions for phosphorus, nitrogen and potassium, replenishing these elements as they are needed. Test kits are available for such work, but were not used in the project. This often saves the renewal of an entire batch of solution.

Deficiencies

The general health of the plants is often a matter of concern. The solutions may not be prepared accurately, or may not fit the particular plant under study. Students were encouraged to find out what the plant deficiency was, or the cause of the trouble. For advanced students the appropriate procedure would be an analysis of the nutrient solution. But for this project attempts were made to "spot" the deficiency by comparison with tables of deficiencies or with photographs in the reference texts. They were able to correct some by adding extra amounts of the trace elements, others by altering the pH of the solution. For example, some of the petunias showed marked chlorosis after about ten days. This furnished an excellent example for control measures. One plant was left untreated, and others treated

with iron solutions of various concentrations. The results were carefully noted.

Results

The general results of the student experiments have been arranged in Table 1. This is a summary of the entire series of experiments, over a period of two years. In some cases the tests were repeated to verify the results.

Tomatoes proved to be the most "popular" specimen. There were several varieties tested, Marglobe giving the best results. In general, the plants were very sturdy and blossomed freely. Some of these bore firm fruit. The plants must be strongly supported, especially in direct water culture.

Peas were not very satisfactory. The students had much difficulty with excess moisture and insufficient aeration.

The rose specimens were quite spectacular. Dormant bushes were used. The group was careful to give proper aeration, and to keep the crown of the bush well above the solution. This was absolutely necessary for all of the plants, a fact learned by a few sad experiences.

Given proper aeration the caladiums were the easiest specimens to handle. All of the solutions seemed to be very satisfactory, and results consistently excellent.

The group working with the Ohio WP solution was not satisfied with their results with tomatoes. They promptly changed solutions and proceeded with different specimens. Their failure to obtain good results cannot be attributed to the nutrient solution itself, but to the individuals involved.

The results with tulips were particularly interesting. They are not native Louisiana garden bulbs, and are rarely attempted indoors. The blooms attracted many visitors.

In addition to the plants studied, chrysanthemums, gardenias and carnations are desirable subjects for most localities. Under best garden or greenhouse conditions the two last mentioned are fairly difficult to raise in Louisiana, and were not attempted by the students.

Of course the range of the project was governed by laboratory space. No greenhouse space was available. Plants were arranged on window-sills and on tables directly in front of windows. They received strong sunlight during the morning. Those requiring less sunlight, such as the ferns and some of the bulbs, were placed about five feet from the windows.

The plant rooms were separated from the main laboratory. In one of the rooms there was a demonstration bee hive with an active swarm of bees. The bees visited the specimens daily. The students used a smaller room as a preparation room. Thus the project did not interfere with the routine classwork.

The results were extremely gratifying to the students. There were some failures and disappointments, but many valuable lessons were learned.

Commercial Preparations

There are a number of commercial preparations available for nutrient solutions. Some of these are

(a) *Plant-Chem Salts* (University Hydroponic Service, Berkeley, Calif.).

(b) *Plantank Nutrient* (Chemical Garden Co., Evanston, Ill.).

(c) *Clark Gardner Mixture* (Clark Gardner Nurseries, Osage, Iowa).

(d) *Kem Plant Food* (Kem Plant Food Corp., New York, N. Y.).

(e) *Hyponex* (Hydroponic Chemical Co., New York, N. Y.).

Samples of all of these were not available for student testing, but some of them were included in the work of Group 8.

Special Combinations

Certain groups, reading about the results obtained with Vitamin B_1, prepared

some specimens using the California #2 solution and treating with various concentrations of the Vitamin B_1 solution. Samples of the fluorescent dye, commercially called *Photo-Sen-Sin*, were also used, with the nutrient alone and then with nutrient and Vitamin B_1. There was no striking difference obtained when these materials were used, as compared with the plain nutrient solution.

Areas for Further Study

There are many other types of plants which would make interesting specimens for nutrient culture. A project based on cotton grown in solution may be developed in the South. For those schools having greenhouse facilities, the bench methods offer many possibilities.

For advanced classes, junior college or college level, the basic project may be expanded to include the analysis of tissues, or of the fruit themselves, determining the relative proportions of the chemical elements necessary for growth. Microchemical analysis is best adapted for this.

The effect of artificial illumination on plant growth is being studied. Nutrient culture is excellent for such tests. On a small scale the reactions of seedlings or growing plants when exposed to unusual quantities of light, or to light of a certain color, furnish a unique experiment for high school students.

Advanced students may utilize radioactive elements as tracers. Radioactive potassium, phosphorus, sodium and bromine may be introduced into the nutrient formulae. The paths of the radioactive materials, quantities in various locations in the plants may be tested with Geiger counters or electroscopes, or by direct contact photography.

Projects such as the one outlined in this report stimulate students to acquire special skills and techniques not normally asociated with elementary courses. The preparation of the nutrients themselves, with the application of the principles of elementary chemistry, is an example of this. In addition the students gained experience in glass blowing, waterproofing, elementary carpentry, etc. The students, in organizing their own work and carrying it through, not only gained a realization of the importance of chemical elements in plant growth, particularly those occurring in trace quantities, but created in the community a live interest in their work, its outcome, and its value.

Student Reference List

1. Ellis, Carleton, and Swaney, Miller W. *Soilless Growth of Plants.* Reinhold Publishing Corporation, New York, 1938.

2. Hoagland, D. R., and Arnon, D. I. *The Water-Culture Method for Growing Plants Without Soil.* Circular #347, University of California College of Agriculture, Agricultural Experiment Station, Berkeley, Calif. Reprinted 1939.

3. Shive, J. W., and Robbins, W. R. *Methods of Growing Plants in Solution and Sand Cultures.* New Jersey Agricultural Experiment Station, Bulletin #636, New Brunswick, N. J., 1939.

4. Withrow, R. B., and Biebel, J. P. *Nutrient Solution Methods of Greenhouse Crop Production.* Circular #232, revised, Purdue University Agricultural Experiment Station, Lafayette, Indiana, 1938.

5. Biekart, H. M., and Connors, C. H. *The Greenhouse Culture of Carnations in Sand.* New Jersey Agricultural Experiment Station, Bulletin #588, New Brunswick, N. J., June, 1935.

6. Laurie, Alex. *Soilless Culture Simplified.* Whittlesey House, McGraw-Hill, New York, N. Y., 1940.

7. Phillips, A. H. *Gardening Without Soil.* Chemical Publishing Co., New York, N. Y., 1940.

8. Matlin, D. R. *Chemical Gardening.* Chemical Publishing Co., Brooklyn, N. Y., 1942.

9. Dawson, C. D., and Dorn, M. V. *Plant Chemiculture.* Third Edition. Published by the authors, Los Angeles, Calif., 1939.

10. Matlin, D. R. *Growing Plants Without Soil.* Second Edition, Revised. Chemical Publishing Co., New York, N. Y., 1940.

11. Connors, Charles H., and Tiedjens, Victor A. *Chemical Gardening for the Ama-*

TABLE 1

Group	Plant	Source	Culture Type	Nutrient	Results
1	Tomatoes	Seeds	Water	Calif. #1	Fair. Blossoms, no fruit.
	Tomatoes	Seeds	Sand	Calif. #1	Good. Blossoms, some fruit.
	Tomatoes	Seeds	Gravel	Calif. #1	Fair. Blossoms, no fruit.
	Caladium	Bulb	Glass wool	Calif. #1	Excellent. Beautiful leaves.
2	Tomatoes	Seeds	Water	Calif. #2	Good. Blossoms, fruit.
	Tomatoes	Seeds	Sand	Calif. #2	Excellent. Blossoms and fruit.
	Tomatoes	Seeds	Gravel	Calif. #2	Excellent. Blossoms and fruit.
	Tomatoes	Seeds	Trough	Calif. #2	Fair. Blossoms, no fruit.
	Corn	Seeds	Water	Calif. #2	Poor. Good growth, no flowers.
	Begonias	Cutting	Sand	Calif. #2	Excellent. Strong growth.
	Caladium	Bulb	Glass wool	Calif. #2	Excellent. Large leaves.
	Peas	Seeds	Trough	Calif. #2	Fair. Good growth.
3	Roses	Nursery	Water	Calif. #2	Good. Blossoms.
	Strawberry	Nursery	Sand	Calif. #2	Good. Blossoms, fruit.
	Roses	Nursery	Gravel	Calif. #2	Poor. No blossoms.
	Crotons	Nursery	Sand	Calif. #2	Ailing plants revived.
	Snapdragon	Nursery	Gravel-sand	Calif. #2	Poor. No blossoms.
	Tomatoes	Seeds	Sand	Calif. #2	Good. Blossoms, fruit.
4	Tomatoes	Seeds	Water	N. J. #1	Fair. Blossoms, no fruit.
	Tomatoes	Seeds	Sand	N. J. #1	Good. Blossoms, fruit.
	Tomatoes	Seeds	Gravel	N. J. #1	Fair. Blossoms, no fruit.
	Oats	Seeds	Sand	N. J. #1	Fairly strong growth.
	Corn	Seeds	Sand-peat	N. J. #1	Good. Tassels, ear.
	Corn	Seeds	Gravel	N. J. #1	Fairly strong growth.
	Peas	Seeds	Sand	N. J. #1	Poor. No results.
	Peas	Seeds	Gravel	N. J. #1	Fairly good growth.
	Sweet peas	Seeds	Gravel	N. J. #1	Poor. No flowers.
	Caladium	Bulb	Glass wool	N. J. #1	Excellent. Strong growth.
5	Tomatoes	Seeds	Sand	Purdue 2D	Poor. Blossoms, no fruit.
	Tomatoes	Seeds	Gravel	Purdue 2D	Poor. Blossoms, no fruit.
	Caladium	Bulb	Glass wool	Purdue 2D	Excellent. Fine growth.
6	Tomatoes	Seeds	Sand	Ohio WP	Poor. Blossoms, no fruit.
	Fern	Nursery	Sand	Calif. #2	Good. Healthy growth.
	Geranium	Nursery	Water	Calif. #2	Good. Healthy plants.
	Geranium	Cutting	Sand	Calif. #2	Good. Healthy plants.
7	Lupines	Nursery	Water	Calif. #2	Fairly good. Some blooms.
	Marigolds	Nursery	Water	Calif. #2	Excellent. Good blooms.
	Petunias	Nursery	Water	Calif. #2	Good. Some blooms.
	Zinnias	Nursery	Water	Calif. #2	Fair. Some blooms.
	Snapdragon	Nursery	Water	Calif. #2	Fair. Growth slight.
	Caladium	Bulb	Sand	Calif. #2	Excellent. Fine growth.
8	Narcissi	Bulb	Gravel	Calif. #2	Good. Fine blooms.
	Narcissi	Bulb	Gravel-peat	Clark-Gard.	Excellent. Many strong blooms.
	Daffodils	Bulb	Gravel-peat	Clark-Gard.	Excellent. Many strong blooms.
	Grape hyacinths	Bulb	Gravel-peat	Clark-Gard.	Excellent. Free bloomers.
	Tulips	Bulb	Gravel-peat	Clark-Gard.	Excellent. Fine specimens.
	Dutch hyacinths	Bulb	Gravel-peat	Clark-Gard.	Excellent. Not as many blooms as other bulbs.

teur. Wm. H. Wise and Co., New York, N. Y., 1940.

12. GERICKE, W. F. *The Complete Guide to Soilless Gardening.* Prentice-Hall, New York, N. Y., 1940.

13. BALL, VICTOR. *Gravel Crops.* George J. Ball, Inc., West Chicago, Ill., 1939.

14. TURNER, WAYNE I., AND HENRY, VICTOR M. *Growing Plants in Nutrient Solutions.* John Wiley, New York, N. Y., 1939.

15. LAURIE, ALEX, AND KIPLINGER, D. C. *Commercial Flower Forcing.* Fourth Edition. Blakiston, Philadelphia, Pa., 1944. (This text was not available in its present form for the experiments, but it contains excellent material on gravel crops.)

From the Managing Editor

It is with a great deal of pleasure and satisfaction that we look back over the records of the last four volumes of THE AMERICAN BIOLOGY TEACHER and see that the advertising has held its own. As far as the net profit is concerned, we are ahead because the collections are comparatively high. This was done in spite of the fact that the advertisers admittedly had less goods for sale than there were buyers. To be sure, we gave them real value in advertising, because as you know, the journal is sent to all of the forty-eight states as well as some foreign countries. Nevertheless, other publications bid for this business and we must show reason why our journal should get the call.

The war caused a drop-off in advertising. Our old reliable concerns who have been with us regularly for the past five years told me they were continuing their copy in order to keep god will. So, when biology teachers purchase equipment it would be well to keep those advertisers in mind who have favored us in the past. In this connection we would like to name those who have been with us for five years or more. They are, *Bausch & Lomb Optical Company*, *Spencer Lens Company*, *Denoyer-Geppert Company*, *General Biological Supply House*, *Carolina Biological Supply Company*, *Marine Biological Laboratory*, *Visual Sciences*, *Chicago Apparatus Company*, and *Biological Abstracts*. There are several others that advertise occasionally, and we are pleased to have them with us.

It is the duty of the Advertising Manager to sell the ads for the publication which he represents and then convince the buyer that he should pay promptly. Consequently, it is wise not to oversell the prospective customer. We have been very fortunate in the quality of the firms to whom we have sold space in the journal, for our collections have been one hundred per cent for the past three volumes.

No doubt some of our readers will be interested to know a few of the ways in which we appeal to those whom we wish to convince that our advertising pays. First of all, the buyer of space must be satisfied that our journal offers him better possibilities to tell of his product than other publications in the same field. His adds should be read by many people over the area in which he is able to ship his goods. We endeavor to make him feel that he should continue to use our space. Here are three of many short statements in our collection we find interesting and helpful along this line. WHEN TO STOP ADVERTISING: 1. "When every man has become so thoroughly a creature of habit that he will certainly buy this year where he bought last year." 2. "When nobody else thinks it pays to advertise." 3. "When you have convinced everybody whose life will touch yours, that you have better goods and lower prices than they can ever get anywhere outside of your plant."

January 1, 1945, marks the end of five years of service I have given to THE AMERICAN BIOLOGY TEACHER. One and one half years of this time was spent as assistant manager with Mr. Fried, and the remainder has been as manager. And to be frank, the work has been most enjoyable.

When this job was undertaken, there was no doubt in my mind that many friendships could be made, and that was foremost with me. This I believe has been done as well as give service to the organization. If this had not been the

case, I would have been reluctant to continue, because enmity is often made in attending to one's own business without going out of the way to find it. There have been many fine friends among the advertisers also, and I shall regret not having the opportunity to visit with them as was the case in the past.

There is need in our association for workers who are young in the biology field. Work in *The National Association of Biology Teachers* will offer them the opportunity to serve, and at the same time get acquainted with some of the finest people in all of the science fields. I would like to appeal to any of you who wish to help to offer your services to the officers at the regular annual meeting, or any time during the year. Surely it is the wish of all those serving now to have as large number of the members as will volunteer to help out with the many tasks which have to be performed if this association grows at it should.

To my own surprise, I have remained longer at this job than was anticipated upon entering it. No doubt one of the contributing factors was the fact that advertising was difficult to get and hold, and it was my belief that an older man could better do this than a new one. At present, it seems to me that we are in good shape—collections all in, advertising contracted for in sufficient quantity to survive the year, and other things in our favor—therefore, I wish to turn this work over to others.

CHAS. B. PRICE

PLAN FOR LIVING MEMORIAL

Boulder High School has lost about twenty boys in World War II. The student body feel that they would like to honor these boys at this time with a living memorial, a monument of such floral beauty as would serve to remind those who see it that our freedom is dearly championed and something to be cherished.

The campus of Boulder High School consists of a large lawn surrounding the building. Boulder creek runs through the grounds. On the north side of the creek is the high school building and tennis courts, on the south side is the football field, a good field house and a caretaker's home. West of the football field is a large victory garden behind which is a planting of 150 evergreens. It is this garden that the Student Council of the Boulder High School is considering as a plot for planting lilac bushes for our living memorial. We plan to purchase the lilac bushes from the Rockmont Nursery of Boulder which has developed some of the most beautiful lilacs in the world. They are hybrids developed by the late D. M. Andrews. The Biology classes, who have the care and planting of the Victory Garden, plan to give up that space for the planting of our living memorial. The hillside on the south of the stadium offers another desirable site for the planting of such a memorial. We intend to call for the services of a landscape artist before coming to a final conclusion. We would like to begin planting as soon as possible.

Wherever the memorial is planted it will be accompanied by a stone tablet with the names engraved upon it of those boys who made the supreme sacrifice.

The planting of living memorials will enrich the lives of the people as well as provide an honor and a living tribute to the heroes of the war. It would be interesting to know the plans of other high schools.

RICHARD ROGERS, *Student Chairman, and Committee*, under direction of MAUD REED, *Biology Instructor, Boulder High School, Boulder, Colorado.*

THE SOUTHERN CALIFORNIA ASSOCIATION OF LIFE SCIENCE TEACHERS

Representatives of the Association served on the planning committee for qualifying courses of Natural Science for *Museum Junior Leaders,* and the Association is sponsoring the courses, given under the auspices of the section of Education of the Los Angeles County Museum.

The subjects are birds and mammals, botany, fossils, insects, marine biology, minerals, reptiles.

To qualify as a *Museum Junior Leader,* a student must take any two of the above subjects and a five-week series of general lectures which review for the entire student body all of the subjects given. The 1944–45 courses were open to all students who completed the spring 1944 courses, and to junior and senior high school students except those in the seventh or twelfth grades. The seventh grade student needs all of his time to make the adjustment from elementary to junior high school. For the high school senior there is not enough time left after the completion of the course to serve as a museum leader.

All preliminary courses were limited in registration. Teachers were asked to give careful thought before recommending a student. Outstanding achievement in his science work in school and leadership ability were considered to be essential prerequisites.

The 1944–45 course extended from September 23 to February 10, with the graduates receiving certificates as *Museum Junior Leaders.* Plans are now under way for the spring 1945 course, registration for which will be accepted after February 15, 1945. This course will start in April and be completed in June, the exact dates to be announced later.

GJERTRUD HJORTH SMITH,
President

TO EVERYONE—GREETINGS!

As luck would have it, I was able to attend the meeting of the *American Association for the Advancement of Science* at Cleveland last September. While attending this national affair, I was privileged to take in several gatherings of the NATIONAL ASSOCIATION OF BIOLOGY TEACHERS—the first time since I became a member.

At no meeting of any biological society, for the past thirty years, have I found such a devotion to the aims, ideals, and purposes of the organization as at the Cleveland meeting of the N. A. B. T. The spirit seemed to be: "We can do a lot for our country through the teaching of biology." And I felt: "This is a society to which every true American who teaches biology should belong." Certainly, if the teaching of biology is our life-job, then the N. A. B. T. comes nearer being the central organization of our profession, than any other organization, into which all our other societies must converge, and to which, if worthy, they may contribute. This is logical and natural. THE NATIONAL ASSOCIATION OF BIOLOGY TEACHERS is, indeed, our own society, and should be supported by every biology teacher in grade schools, high schools, normal schools, teachers colleges, liberal arts and science colleges and universities, yea, even the medical colleges. All such teachers and the libraries of their institutions should be earnestly eager to belong. And our motto should be: "Once a member of the N. A. B. T., always a member." It being understood, a real member is one in good standing, paid up for a year or more in advance.

While at the Cleveland meeting, I was made Chairman of the Illinois Membership Committee. Now, while it is in that capacity I am writing, I had it in my heart to pen this note to you for inclusion in our journal before I was appointed membership chairman for Illinois.

What I have written here comes from my very heart. I am a citizen, a native of Norway. I love my adopted country very much, and I feel that a tremendous amount of good can be done by biology teachers for America if we but take ourselves seriously enough. I am sure it would be helpful in many ways to take an active part in the N. A. B. T. And, those of us who are members now, let's each get a new member every year until every biology teacher belongs actively. THE NATIONAL ASSOCIATION OF BIOLOGY TEACHERS can do much for our country if biology teachers only dare to live a full life of teaching patriots. Long live the N. A. B. T. *Long live America!*

H. P. K. AGERSBORG,
McKendree College,
Lebanon, Illinois

COMING SOON . . . a cross-word puzzle on flower parts, submitted by M. Blanche Cochran, of Coatesville, Pennsylvania . . . more of the excellently illustrated short articles by Donald Lacroix, of Amherst, Massachusetts . . . *Cancer Education in High School,* by Dr. Frank L. Rector of the Michigan Department of Health . . . biology activities for the opening day of school.

HOMER A. STEPHENS, former president of The National Association of Biology Teachers, is a member of the Army Air Forces, on active duty (at the time of going to press) in the Marianas Islands.

The Birds Understood Global Geography before We Did!

Using colored yarn or thread to mark out on the globe the migration routes of birds. Photo by the author.

MIGRATION ROUTES OF BIRDS

When studying birds, the matter of migration occupies a most interesting position. Questions come thick and fast from boys and girls as soon as any discussion of bird migration is opened. A very compelling way to bring out the distances covered by some of the migrants and to impress these tremendous "travelogs" on the minds of youngsters is to mark them out on a regular classroom globe—the method used to demonstrate modern geography.

Two or three pupils spend a day or two in reading up all material available on this topic. Then with lengths of colored thread and a few drops of melted paraffin the migration routes are marked out on a regular globe. For instance, a piece of blue thread stretched from Arctic to Antarctic and held in correct position by a drop of melted paraffin here and there will serve to show the migration route of the Arctic tern. A red thread can be used to show where the golden plover goes—and so on. If a few such routes are lined out thus on a globe, this very helpful teaching tool can be utilized to advantage when the whole class is talking over the interesting business of migration.

DONALD S. LACROIX,
Amherst High School,
Amherst, Massachusetts

A Method of Cataloguing and Filing Kodachromes

RICHARD L. WEAVER
Educational Director, Audubon Nature Center, Greenwich, Connecticut

After one has added the five-hundredth kodachrome slide to his teaching or lecturing library of natural history pictures, it becomes increasingly difficult to file the slides so as to be able to find particular ones for instant use.

When I was faced with this problem some years ago, I tried to find a suitable system, but in vain. I even tried to adapt the various systems used for filing natural history books and leaflets but they were not very practical for the purpose. Therefore, I began a series of experiments which have culminated in a fairly workable system for cataloguing and filing natural history slides. Needless to say, there are many faults to find with it, and it will not be entirely satisfactory for anyone else without modifications based upon his specific interests.

Since the subjects fell rather easily into several large fields of interest, I made five major classifications and gave each one a color as follows:

Plants	green
Animals, other than birds	blue
Birds	red
Ecological subjects	gold
Trips and localities	white

I might have chosen more colors but these seemed to be all that were readily available at the time. Dennison circular gummed dots were available in red, blue, and green. Gold dots were punched from gummed seals, while white ones were easily made from Dennison gummed labels.

These gummed dots were placed on the upper right hand corner of each slide to act as guides for placing the slide into the projector and also as a place to write on the classification letter and numerals with india ink.

Each color group was then divided into letter divisions, using letters which represented some connection with the subjects, although a letter could be used only once for each color. Thus twenty-six letter divisions would be possible in any one color. Some improvisation is necessary in the choice of letters when any one letter seems the logical one for more than one group. The following letters were chosen for the divisions under plants set aside with green dots:

M—mosses, club mosses, and horsetails
L—lichens and fungi
F—ferns
T—trees and shrubs
S—seeds and fruits
A—alpine flowers
R—rare flowers
P—s*p*ring flowers
U—s*u*mmer flowers

The animals were separated more or less taxonomically as follows: *A*, amphibians, *I*, invertebrates, *F*, fish, *S*, snakes and turtles, *M*, mammals.

The birds also could easily be divided taxonomically into ducks, shorebirds, finches and the like, but I relied more on the subjects which I would be photographing and using for natural groups in lecturing. For instance, I copied all of the colored plates in Forbush's ***Birds of Massachusetts and Other New England States*** so these were set aside by *F* for Fuertes, the artist (or Forbush,

the author). All pictures of bird houses and feeders were labeled *A* for attracting birds, *B* was used for copies of other book plates, *P* for my own bird pictures, *S* for those having to do with structure and adaptations, and *M* for migration routes, flyways, and ranges. *G* was reserved for a series of 50 pictures of gannets and related pictures taken at the same time on Bonaventure Island.

Ecological pictures included such topics as *H* for habitats, *C* for seasonal change, *S* for sanctuaries, *I* for conservation industries such as farming, hunting, lumbering, *G* for geology, and *M* for meteorology. Here again one's interests determine largely the choice of letters.

Trips and localities naturally vary with one's experiences, but usually each trip taken with photography as the objective will produce a distinct set of homogeneous pictures and can be designated as: *G* for Gulf of St. Lawrence, *O* for Oglebay Park, *L* for Lost River, *P* for Plymouth, *W* for Mt. Washington, *D* for Dartmouth, *N* for New Hampshire scenes other than those in the above groups, and *S* for singles or short series for a miscellaneous division.

As for family pictures, I used blue for these and selected the initials of individual family members unless they conflicted with the ones used in the group above. If one of the above major groups could be eliminated such as the gold one, or other colors found they could be used for topics other than natural history ones.

After all slides have been given a color and a letter, a number is selected. These can be given chronologically as taken, alphabetically, or in the case of trips in the order which they will be used. For example, a slide with a red dot labelled M 26 is the 26th of a set of slides on migration of birds. When in a natural group such as the Fuertes plates they can be numbered according to the pages of the book. Since one keeps adding pictures in some of the divisions, adaptations will have to be made and occasionally a revision may be in order.

If an alphabetical group under one color approximates one hundred slides (the maximum of most of my filing boxes), it is placed in a separate box and a list is fastened into the lid of the box with the numbers and the subjects corresponding to the slots in the box. An adhesive tape label with proper color dot is placed on outside of the box. This makes it fairly easy to select the slides for use. When the divisions are small all the slides of one color are placed in one box with a few spaces or slots separating each letter group, and the series listed on the lid.

If a division becomes too large or is more or less stabilized by having no further additions, the slides can be reshuffled to an alphabetical, seasonal, or other logical sequence and each one given a new dot and number. The new dots are glued over the old ones. Thus one can bring two pictures of the same plant taken at two different times of the year and originally some distance apart, together under one permanent cataloguing.

By typing the various sequences on notebook paper and making a carbon copy which can be cut to fit into the lid of the filing box, the inventory of all of the slides can be arranged by color in a notebook, with separate pages for each division so as to allow for additions. The duplicate list placed in the box permits a rapid survey of the contents for selection when using them.

After slides have been removed from various boxes and divisions for a lecture and are ready to be replaced, they are quickly separable into color groups, then into letter groups, and finally returned to the boxes in sequence. A glance at the empty spaces in the boxes will also show any lost or misplaced slides.

"Education for All American Youth" from the Point of View of a Biologist*

OSCAR RIDDLE
Carnegie Institution, Department of Genetics, Cold Spring Harbor, New York

In a small span of time I am here obliged to discuss all or parts of a comprehensive plan[1] for doing many kinds of things which relate to education. I have chosen to consider only certain items which I believe should be criticized adversely. Before stating those criticisms, however, I must compliment the Commission for making many sound and forward-looking recommendations. Here I refer to such things as its particular plan for Federal aid to education; to its plans for the "community institute"; and to its insistence that today is better than tomorrow for the "planning of the kinds of schools which America needs and must have."

You who have studied the Commission's report are aware that a fairly large section of it centers upon the curriculum, and upon the ideals and means of education of youth aged 15 to 19, inclusive. On this vital subject it is true that the report says that its recommendations—which are certainly very fully described—are not "blueprints"; also, that they are offered as "samples." Thus, it appears that constructive criticism is invited; and surely that criticism will be supplied by some or many members of the large family of the sciences. But, we ask, will a useful service be performed by sound criticism if an *Education for All American Youth* is everywhere to be set going on the basis of the volume already placed in the hands of school authorities and administrators throughout the country? Here, apparently is a first point at which this volume and plan may be open to criticism. The volume offers a "sample" curriculum, but this is offered under such circumstances, prestige and sponsorship that any suggested improvement upon that "sample" is likely to compete either not at all, or at much disadvantage, with the one so widely publicized and supported in this book. Are we to understand that the Educational Policies Commission stands ready to give its sponsorship and equally wide distribution to one or another "sample" curriculum which differs significantly from the one it has published?

Both at "Farmville" and at "American City" it is proposed that a course called "science" should get one-sixth of the 15-year-old youth's time in Grade X; but no youth is slated for more. During that same tenth year, this youth gets an exactly equal amount of time for recreation plus physical education, and this latter is repeated in whole or in part throughout a five-year program. Besides, health and mental hygiene get about one-twelfth of the youth's time throughout a five-year period. Examination of the content, or even the full title, of this single year of "science" leaves no doubt that the thing to be taught is not *a* science, nor yet is it *the* sciences—it is *about* science. Its specific name is *The Scientific View of the World and of Man*. To teach this course a laboratory is apparently not essential.

* This paper was presented at the annual meeting of the Middle States Science Teachers Association, New York, Nov. 25, 1944.

[1] By the Educational Policies Commission, 421 pages. 1201 Sixteenth Street, Washington, D. C.

Again, no double periods are provided for this course in so-called science, though double—even triple—periods are carefully provided for the proposed social-studies course called "community studies." Concerning this course on *The Scientific View of the World and of Man* we quote, in part:

"Without attempting to describe it in full, we may point out a few of its features. Imaginative association with great scientists is used as one effective way of learning about scientific methods. The history of science is full of adventure and dramatic action, which appeal strongly to young people's interests and arouse their imagination. The lives of some of the great scientists are studied, representing the major scientific fields. . . . Some of the great scientific experiments are also studied, which are within the comprehension of tenth-graders—experiments of recent years as well as of the remote past. Whenever possible those are repeated in the school laboratory. Students see how the experiments and discoveries of scientists have changed our ways of living. . . . Throughout the year, an attempt is made to add to the student's stock of fundamental scientific principles and facts, and to help students see these as related parts of a whole. . . ."

Now all of us will agree that it is highly desirable that these and many similar things become the possession of every youth; but many experienced teachers of the sciences will insist that these ends cannot be attained in this kind of course pursued to the extent of one-sixth of the youth's time during one year. Many competent teachers will maintain that these aims, together with the grip on reality which only personal laboratory experience can develop, are worth not merely one-sixth of one year's time, but at least one-sixth of four years of the youth's time—from the ninth to twelfth grades, inclusive. Two years of properly organized study of the living world, and another two of the physical world, can be expected to substitute conviction and familiarity for the proposed vaneer of classroom conversation about principles and natural laws. And, such study can develop still other enduring civic values which must pass unnoted here. Exact and exacting studies do a thing that is tonic and leavening to human beings and to nations. The mental emancipation of majorities, absolutely and always needed among us, conditions the taking of forward steps in many areas of legislation and of community and family life. It cannot be conceded that this mental emancipation along with a much more definite familiarity with our own bodies, our environment, and the natural world, is a poorer preparation for good citizenship in the Democracy of days ahead than is the proposed "investigation of current political, economic and social problems" which the plan actually projects even to the nineteenth year of the youth's training. Indeed, in these days of national emergency it should be clearer than ever before that a prime responsibility of the school is partly to equip the citizen with science and the method of science for his life in an age of science.

The "sample" curriculum submitted by the Commission gives inadequate recognition to the role of the sciences in education; and, insistence upon all of the "social studies" of that plan would sharply limit the amount of time that many youth could give to study of the several sciences. This would be particularly true for such youth as might wish also to pursue vocational studies.

Health study. There should be clear recognition of the importance of interrelationship, and of sequence of instruc-

tion, in the two subjects—biology and health. This is ignored in the Commission's plan, just as it is most unfortunately ignored by the new law of the State of New York requiring the teaching of health in its schools. Let me make it clear that I am among those who think there should be sound instruction in health and hygiene in the high schools. For some years I have spoken and written in support of such instruction. But I am not *frantic* about it. Many more unawakened minds than sick bodies graduate from high school. A sick body may be a threat to the individual; in a Democracy an unawakened mind is certainly a threat to us all.

The plan we are now discussing seems to throw more of pressure than of light on this subject. Let us indeed make a reasonable effort to teach the foundations of health; and in the high school let us arrange to teach it in connection with, or following, courses in human physiology or in biology. These science subjects supply the main foundations for the technology—the hygiene. Everywhere else the rule is—the basic sciences first, technologies and application afterward. Just what are the valid reasons that the ideal high school of the future may not somehow make contact with this principle which is so well established at the college level?

It is not exactly a digression to note another very broad but often forgotten way in which biology and health are most intimately related. From past decades and centuries there is a trickle or overflow of parts of the philosophy of biology which helps the majority of us to be partly rational on larger health problems during at least part of the time. Indeed, the fragments of biological reality that our people dimly know and accept do very much to protect us against what we may call Gandhiism. To the biologists of the world Mohandus K. Gandhi has made evident the principal thing that is wrong with him and with India. Some years ago Gandhi—political and spiritual leader of about one-seventh of mankind—seems to have said: "We have no right to take the lives of mosquitoes, flies, lice, rats or fleas. They have as much right to live as we." Here is complete and unmistakable defiance of the total of our biological knowledge and of the philosophy that flows from it. Here also is clear evidence that—under the sway of Gandhiism—the real rulers of India are disease, poverty, *unreality* and death. Life expectancy there is less than *30* years.

We may remind our non-biological colleagues that the *education* of Gandhi has not been proved equally deficient in other areas of learning, nor in the rules of trade. His concepts of civil law and of letters do not seem to be similarly perverted; his arithmetic and history are apparently neither deficient nor set in reverse; and certainly Gandhi and India have plenty of religion. It may properly be said that Gandhiism is, basically, a continuance of battle against biological realities. Also, that, in his country, pain, disease, poverty and unreality will continue to rule until biology displaces the ridiculous in the minds of its people.

The philosophy of biology puts all that lives in a sea of change; it marks the tides of variability, and also those of order and adaptation, in every living species; it deals with grades of organization which the oceans must have helped to form but can not imitate; it finds man—individually the creature of both natural law and of chance—on the moving crest of the wave of life. But, despite the relative simplicity of these concepts, and of the array of facts that lead to them, all this cannot be learned in the same amount of time that elementary high-school algebra is learned. If we want our people to "know themselves"

we must increase the time and skill which we devote to the teaching of the life sciences in our secondary schools. And, let us note, neither the history nor the nature of life is intelligible apart from chapters on earth science and chemistry.

If we want our youth to be able to share in guarding their own health, and if we want our people generally—not just a part of them—to seek and accept the ministrations of modern medicine, we have no alternative to instructing all of our people adequately in real biological science.

There is one reason, almost never mentioned, why in the days ahead biology *must* be taught widely and well in our Democracy. It is this. At present only biologists may be expected to teach the fact, and the foundations of the fact, that human beings are genetically and biologically *un*equal. Certainly neither sociologists nor theologicians can now be relied upon to go much further with this principle than to acknowledge the existence of male and female. That particular inequality happens to be both fortunate and pretty well known; the ones to which I refer are serious and largely unacknowledged inequalities which may prove more dangerous to Democracy than to other forms of government. As a biologist, more or less familiar with human and animal genetics, I am aware of the gradations of abilities, possibilities and susceptibilities among the members of all communities—even in the same families—that depend upon the chance union of genes. But I am even more impressed with the circumstance that it may be highly dangerous for present and future youth of this country to fail to learn, assimilate and accept this reality. Data published[2] two years ago by a committee of which I was chairman indicated that about 6 of 7 of the responding biology teachers taught this principle. Those teachers indicated that in their schools this principle was very rarely taught in social-studies classes.

If the combined experience of the Educational Policies Commission suggests that the minds of American Youth *cannot* be kept or made alert to the facts, principles, vistas and practical values of science, that is highly important; and, they should say so. For, to them and to all, it must be clear and certain that the youth for whom they plan must live in an age shaped and being reshaped by science, and that these youth cannot escape repeated and important decisions on complex social adjustments imposed by scientific discovery. Following and during a war experience in which our personal safety and our national success alike have been found to depend so greatly upon widespread instruction in the several sciences, it is a paradox that we meet—head on, and even before that emergency passes—a full-scale plan which subordinates the teaching of the sciences in our high schools.

A rereading of the Commission's report prompted some random thoughts on the Forgotten Youth. We had supposed that there were youth of 15 years, particularly at "Farmville," whose health caused only rare concern and then got prompt attention from parents and the family doctor. Youth who had 24-hour days, and who, outside of school, had fair access to both exercise and play. Youth who had somehow learned about baseball, marbles and darts, and perhaps brought these and other skills to school with them. Youth, of "Farmville," who got from parents or other oldsters, and from their own work or wanderings, at least a meager introduction into the human activities, resources, organizations and institutions of their community.

[2] The teaching of biology in secondary schools of the United States. 1942. Science Press, Lancaster.

Youth, of 15, who—despite schooling—had retained a bit of the enquiring mind and who actively sought adequate answers to questions about themselves and the world of things around them. Youth, who could loaf but had come to look in earnest toward a preparation for life; and who therefore preferred attentive and continuous training to time out while he or others learned a new game or rehearsed an old lesson. Perhaps this Youth was not forgotten in the plan for "An Education for *All* American Youth"; for one reader of that plan—in some respects a superb plan—there is question whether this Youth was properly remembered.

Books

WECKSTEIN, A. M. and others. *Directed Activities in Biology.* Oxford Book Company, Inc., New York. vi – 346 pp. illus. 1941.

Among the important features of this interestingly titled, well-organized workbook for high school biology are unit organization, unit previews, detailed page references for each unit for most of the leading high school texts, systematic re-introduction of important material under distinct contexts, and supplementary questions for extra credit. A complete objective testing program of bound perforated sheets accompanies the workbook.

The authors state in their preface that the content of *Directed Activities in Biology* provides complete coverage of elementary biology as taught in the leading school systems. The reviewer would be inclined to agree with this statement. If you are looking for a well-rounded workbook, *Directed Activities in Biology* is most worthy of your consideration.

RAY KENNELTY,
DuBois High School,
DuBois, Pennsylvania

RAFINESQUE, C. S. *A Life of Travels.* Verbatim reprint of the original and only edition (Philadelphia, 1836). Foreword by Dr. E. D. Merrill (Harvard University) and a critical index by Dr. F. W. Pennell (Philadelphia Academy of Natural Sciences). Published: Waltham, Mass., the Chronica Botanica Co.; New York City, G. E. Stechert and Co. Vol. 8, no. 2, 68 pp. 3 portraits. 1944. $2.50.

Increased interest in scientific publications of the nineteenth century and their role in forming the modern concept of taxonomy and the basic principles of evolution has led to the republication of the works of Rafinesque, who wrote 900 papers covering a wide variety of interests in many fields. This volume is an autobiography in which he describes in detail and with great accuracy its wanderings through North America and his native homeland in Southern Europe. A learned scholar, delving into zoology, medicine, history, education and poetry, occupying literary and scientific chairs in universities, establishing business and banking firms when in financial straits, visiting contemporary scientists for comparative studies and always seeking some new diversion, even delving into philosophy, he called forth severe criticism. However, in 1832 he forecast the principles of organic evolution and in 1841 Asa Gray admitted that his work on taxonomy was "of high order" and that posterity would some day "render unto him his just desserts."

RUTH A. DODGE,
Johnstown High School,
Johnstown, New York

Rising expenses will increase the cost of printing THE AMERICAN BIOLOGY TEACHER. *This necessitates an increase in dues unless we double our membership.*

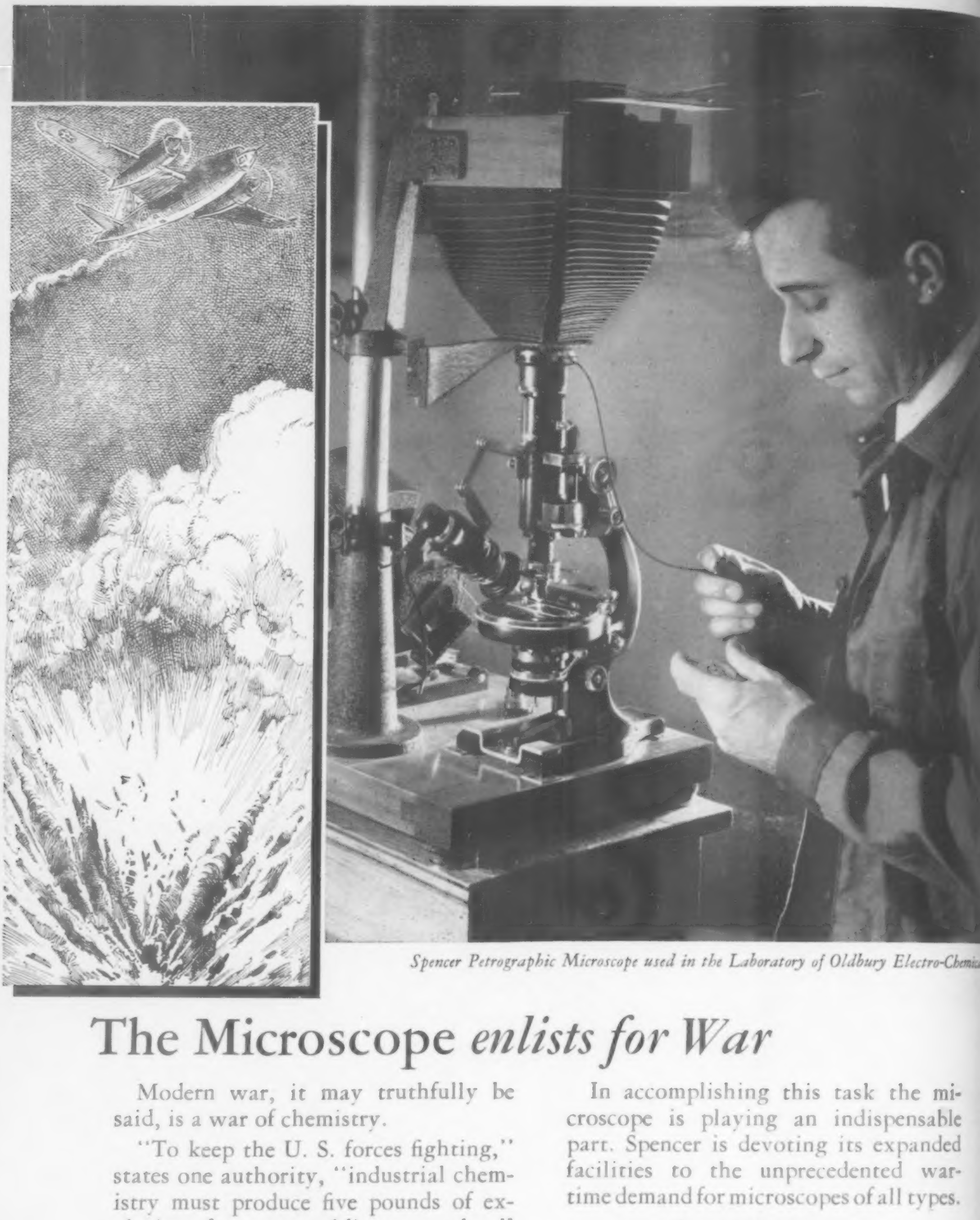
WILL YOU FIND A NEW MEMBER TODAY?

One dollar will provide the January through May Journals and membership to July 1, 1945. For $1.50, the Journal from November through May will be furnished.

If you can spare a *good* copy of the October Journal, please send it to the Secretary.

Best wishes for 1945!

M. A. RUSSELL
403 California Avenue
Royal Oak, Michigan



Spencer Petrographic Microscope used in the Laboratory of Oldbury Electro-Chemical

The Microscope *enlists for War*

Modern war, it may truthfully be said, is a war of chemistry.

"To keep the U. S. forces fighting," states one authority, "industrial chemistry must produce five pounds of explosives for every soldier every day." Incendiary, depth and aerial bombs, smoke screens, flares and most of the ingredients for the devastating fire power of our land, sea and air forces must come from our chemical plants.

More than this, chemistry must create new products, new substitutes, to replace lost sources of rubber, fuels, metals and other materials.

In accomplishing this task the microscope is playing an indispensable part. Spencer is devoting its expanded facilities to the unprecedented wartime demand for microscopes of all types.

ARMY E NAVY

Spencer LENS COMPANY
BUFFALO, NEW YORK
SCIENTIFIC INSTRUMENT DIVISION OF
AMERICAN OPTICAL COMPANY